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Description

In prior patents US-A 3,968,808; 4,026313; 4,290,244; and 4,437,275 various portable shelters are disclosed. In patent US-A 3,698,808, a generally semi-spherical framework made of elongate struts and hub means is disclosed which is movable between a collapsed, bundled condition in which the struts are closely bunched and in generally parallel relation and an expanded condition of three dimensional form. As disclosed, such structural frameworks are self-supporting by virtue of self-locking action, particularly with relation to the modules thereof. This self-locking action is achieved, within a module, by an asymmetrical disposition of those struts which extend inwardly from the crossed pairs of struts defining the peripheral sides of the module. In addition to this asymmetry to achieve the self-locking action, the necessary and sufficient condition for the capability for collapsing as well as expanding is that the sum of the distances from one of a pair of corresponding hub means along a strut to its pivotal connection with a crossing strut and back along the crossing strut to the other of the hub means is a constant value for all pairs of pivotally crossing or scissored struts connected to each pair of inner and outer hub means.

In the 3,968,808 patent, domes, cylinders and modules are disclosed and in the dome structures, the framework is based upon a spherical icosahedron as defined by Buckminster Fuller and one face of which is illustrated in Figures 25 and 27 of that patent. By causing a zone of sliding connections in the framework, as for example as indicated at 110 in Figure 1, three forms of maximum, though incomplete, possible triangular packing within an icosahedron face are disclosed in Figures 25 and 27. The incomplete triangular packing is self evident in Figure 25 whereas in Figure 27, either the crossed pair of struts 344 or the two crossed pairs of struts 340 and 342 are left out in order to attain the expandable/collapsible framework with the aforesaid zone 110 of sliding connections between crossed struts.

In my patent 4,026,313, the full triangular packing of each icosahedron face is made possible by providing alternate zones 18 and 20 of sliding and pivoted connections as shown in Figure 1 of that patent. For a cylindrical framework, the alternate zones are shown at 62 and 64 in Figure 2. Figures 10-12A illustrate rectangular modules of the general type which may be employed in this invention. Patents 4,290,244 and 4,437,275 are divisions of patent 4,026,313 and are directed to modules per se and/or to a module or as assembly of modules in the form of a panel thereof, respectively. Modules such as these may be employed in this invention, although as will be pointed out hereinafter, any module formal which is capable of expanding to three dimensional form and collapsing into a bundle is usable in this invention.

It will be noted that in all of the dome or cylinder structures as disclosed in the aforesaid patents, although it is possible to achieve full triangulation, it is not possible to achieve pivotal connection between all of the pairs of crossed struts due to the necessity for providing the zone or zones of sliding connections.

In all of the dome or cylinder framework structures of the above prior patents, movement from the collapsed condition to the expanded condition involves expansion of the base of the structure from the bundled condition outwardly toward and finally to the fully expanded position of the base. Conversely, when the structure is collapsed, the base retreats inwardly from the fully expanded position to the bundled condition. Expansion or collapse is effected by pushing upwardly on the center of the structure or pulling downwardly on the center of the structure, respectively.

Thus, expansion and collapse in such frameworks occurs progressively within the framework and, more particularly, either expansion or collapsing commences predominantly at the top interior of the framework and expands outwardly therefrom toward the base of the framework, the base dimension in the expanded condition representing the maximum position to which the base expands or from which it retreats.

In my aforesaid prior patents, as in this invention, the framework is covered with flexible covering material to provide a shelter function.

The object of the invention is to provide a portable collapsible shelter frame that is light in weight and can easily be manually expanded and collapsed.

According to the invention this object is achieved by the features as defined in claim 1.

BRIEF SUMMARY OF THE INVENTION

The invention disclosed herein basically differs from the structures of the patents of the prior art in that the geometry thereof allows the structure a wide latitude of different configurations. That is, structures of this invention may take many and different forms by the use of different patterns of basic module configurations. By "module" as used herein, is meant any form of expandable/collapsible module which is of three dimensional form when expanded and is of bundled form when collapsed, whether module is of the self-locking type or not.

This invention involves a framework comprised of interconnected modules and which is capable of being manipulated between expanded, fully arched form and collapsed, bundled form by the expedient of flattening separate arch-like series or strings of end-connected modules of the framework so that their ends are beyond the positions thereof which support the framework when the expanded, fully arched condition.

This invention is based upon a rhombicuboctrahedron. Such as solid has eighteen square faces and eight equilateral triangle faces, a total of twenty six faces in all. Although the complete solid may be made in accord with this invention, in the preferred arrangement the bottom pyramid consisting of five square faces and four triangular faces is omitted. Of the remaining faces, it is preferred that two different module forms by employed which, as herein termed are transition modules and flat modules.

These two modules are arranged in a basic pattern to simulate faces of the rhombicuboctrahedron. The top central region of the basic rhombi cuboctrahedron defines a horizontally disposed flat module of square shape which is bounded on all four of its sides by downwardly arching transition modules with two sides of each triangular face being defined between adjacent sides of the bounding transition modules. In the girthwise direction, the vertically disposed faces are defined alternately by flat modules and transition modules, the flat modules being end-connected to lower ends of the bounding transition modules and further transition modules fill in between such flat modules but in rotationally oriented positions so that their ends join the sides of the girthwise extending flat modules. As noted, adjacent sides of the bounding transition modules define two sides of each triangular face and the base of each triangular face is defined by a further transition module. From this basic arrangement the controlled addition of modules permits the basic rhombicuboctahedron to be dimensionally increased in three mutually orthogonal directions, i.e., in height, in width and in length.

It should be noted that not all of the modules defining the girthwise faces of the basic rhombicuboctrahedron need be employed. Thus one or modules may be omitted to provide entrance openings, as desired. When varying the dimensions of the basic rhombicuboctrahedron, thus providing another shape, transition module means and square modules are added as necessary and desired.

Thus, in contrast to my prior patents where the domes and cylinders may not be basically varied as to shape, a feature of this invention is that the dimensions of the shelter may be controlled individually. That is, for a dome or cylinder of my prior patents, if the interior height is desired to be increased, the base dimension must also be increased commensurately. With this invention, the height may be increased without increasing the base dimensions; the base dimensions may be increased without increasing the height; and the base dimensions may be increased individually (both width and length).

Another feature of this invention is the formation of a shelter framework assembly of the type generally described above in which the framework is separated or is separable from the base upwardly to the corners of the top central region. This leads not only to the dimensionally independent feature noted above but also to an entirely different mode of collapsing and expansion.

Stated otherwise, the invention involves a collapsible/expandable framework comprised of interconnected rectangular modules wherein certain modules forming the framework are either separate or are separable from each other to provide or allow splitting of the expanded framework from the base upwardly therefrom, providing not only the capability for structuring the framework in many different forms but also providing a unique method of movement between the bundled and expanded conditions.

A basic feature of this invention is the capability of structuring the framework in many different forms by the expedient of allowing elongation of the framework in height, length and width, individually or collectively as may be desired.

In accord with the foregoing feature of the invention, two basic forms of module means are involved in this invention, "flat" module means and "transition" module means. By arranging these module means in different patterns relative to each other the aforesaid many different forms of the framework structure are made poss ible. By "flat" module means as used herein is meant an arrangement in which the side faces and the end faces are of rectangular form in which planes passing through the side faces are parallel and planes passing through the end faces are parallel, with the two sets of planes being perpendicular to each other. By "transition" module means as used herein is meant an arrangement in which the side faces are of trapezoidal form and the end faces are of rectangular form in which planes passing through the side faces are parallel but the planes passing through the end faces are not parallel and, preferably, are perpendicular to each other. It is preferred that all circumscribing struts of transition and flat modules are of the same length, in which case the inner and outer faces of the flat modules are of equal size and are square whereas the inner and outer faces of the transition modules are both rectangular and of the same width but with the inner face being shorter than the outer face. It is also preferred that the circumscribing sides of all modules are formed by crossed, pivotally connected or scissored struts.

The frameworks of this invention may be of a form such that when expanded, the four sides of a top central, horizontally disposed and rectangular region are defined by downwardly arching transition modules. Further transition modules may be employed to join lower corners of adjacent transition modules at each corner of the top central region to define triangular modules thereat, thus completely enclosing the top central region by the downwardly arching transition modules and the triangular modules arching downwardly at the corners of the top central region. In this way, the fully enclosed top central region offers an extremely rigid truss-like structure. Strings or series of modules forming arch portions of the framework, in which each string includes a side-bounding transition module, are completed by at least one flat module joined in end-to-end connection with an associated transition module. These strings of modules form supporting legs for the framework. Regardless of the exact configurations of these arch portions or of the number of strings or series employed, they must either be separate from each other from the base of the framework upwardly to the corners of the top central region or be capable of such separation.

The arch portions formed by the series or strings of modules are separate or are split from each other from the base of the framework to the corners of the top central region thereof and the framework is usually sufficiently light in weight to allow it to be picked up off the ground by persons grasping the separate or separated arch portions and then

"walking" the framework either to expanded or to collapsed condition or, if the framework is very large and therefore heavy, the same procedure may be done be mechanical means. Regardless of whether the operation is commenced from the bundled condition or from the expanded condition, the arches are moved outwardly to positions in which the feet of the arch portions are disposed outwardly beyond their normal positions of support for the expanded framework If the framework was expanded before the operation began, the entire framework (i.e., all the modules thereof) begin to collapse in generally uniform fashion as the arch portions are moved outwardly. When the requisite outward positions are reached, their attainment will be apparent because the entire framework will commence to exert inward pulling forces on the arch portions and it remains then to move the arches inwardly while the framework substantially uniformly continues to collapse and further diminish the arch-like nature of the framework. During this procedure, the arch-like nature of the expanded framework continues to diminish and it may then be placed on the ground surface, if smooth and of low friction, whereupon the separate arch portions are further pushed inwardly until the bundled condition is reached. Manipulation from the bundled to the expanded condition is essentially the reverse of the above. As the arch portions are moved outwardly, the framework expands substantially uniformly throughout as the arch-ing thereof progresses. When the maximum outward positions are reached, manipulation of the framework is necessary to compel furtheir arching of the framework as the modules move inwardly until the fully arched or expanded condition of the framework is reached.

Dependent upon the particular configuration of framework employed and the particular configuration of modules employed, certain locking functions may be required when the framework has been expanded and, of course, when such a framework is to be collapsed, unlocking is first required.

The framework is covered with attached flexible material to complete the shelter function of the invention and when the framework has been expanded to its functionally operative condition, the flexible material is held taut by the framework. The covering material may function as a means for limiting the expansions of the modules and for lending stability to the structure, thus participating as a portion of the framework structure as a whole rather than merely as a covering. Generally stated, the covering material must be so related to the structure that it does not interfere with the expanding and collapsing functions, i.e., it may be necessary to separate or split the material as by zippers or the like to allow expansion and collapsing.

In order to provide a framework which has maximum strength, it is preferred that each module of the framework is circumscribed by pairs of crossed, pivotally connected struts.

In one aspect, this invention relates to a portable shelter framework comprised of a plurality of expanded, three dimensional modules distributed throughout the framework, each module including crossed pairs of elongate struts and pivot means pivotally joining said struts for allowing said modules to be manipulated between expanded, three dimensional form and strut-bundled form. The framework includes the combination of a plurality of series of endinterconnected modules each defining an arch portion of the framework, the modules of each arch being bounded on opposite sides of the arch by crossed, pivotally connected pairs of struts and each arch portion including at least one transition module which when expanded defines rectilinearly bounded inner and outer face portions of the arch in which the area of the inner face portion is less than that of said outer face portion.

In one aspect of this invention, there is provided the combination of a series of end-interconnected modules defining an arch portion of a portable shelter assembly framework. The framework is formed of elongate struts and is capable of being expanded into arched three dimensional form and collapsed into bundled form in which struts are disposed in closely spaced, generally parallel relation. In the framework, the modules comprising the series of modules include at least one first module which when expanded de fines inner and outer face portions of the arch portion which they define which are of the same rectangular shape and at least one second module which when expanded defines inner and outer rectangular face portions of the arch portion which are of shapes different from each other.

One module of the series is vertically disposed to present a supporting lowermost end thereof located in a definite supporting position relative to the fully expanded and arched framework and the modules including crossed, pivotally connected struts and hub means pivotally joining ends of the pairs of struts for allowing collapse and expansion of the assembly by manipulating the one module of the series of modules outwardly beyond the supporting position thereof.

The present invention concerns three dimensional frameworks for portable shelters which involve pairs of crossed, pivotally connected struts and hub means pivotally connecting the struts of adjacent pairs of struts in orthogonally patterned end-to-end relation to define modules so that the framework is movable between a collapsed, bundled condition in which the struts are disposed in generally parallel relation and an expanded condition in which the modules and framework are of three dimensional form. The modules are so arranged that a horizontally disposed top central region of the framework is at least partially bounded by transition modules extending in different directions therefrom and which effect a transition angularly from the horizontal disposition of the top region to vertically disposed modules of the assembly, i.e., through an angle of 90°. These modules are disposed in a series or string of arch form in which adjacent modules share common end-defining pairs of crossed, pivotally connected struts. By this construction, the framework may be manipulated between the collapsed condition and the expanded condition by flattening the module strings or arches so that their free ends are positioned beyond those positions which they occupy in the ex-

panded condition of the framework, whereupon the framework may either be manipulated into the expanded condition or into the collapsed condition, dependent upon whether the framework is to be collapsed or expanded.

There may be one or more transition modules employed to effect the full 90° transition.

In a preferred form of the invention, the bounding sides of all of the modules are formed by pairs of crossed, pivotally connected struts in which all of the struts are of the same length. In this preferred form, two forms of modules are used, those in which the bounding side faces enclose a rectangular volume and those in which planes passing through opposite side faces are parallel but where such side faces are of trapezoidal form and the opposite end faces of which are of rectangular form in which planes passing therethrough include an angle which is either 90° or an integral division thereof if more than one such module is used in a string thereof.

In one form, this invention relates to a portable shelter having a framework which is characterized by being movable in a coordinated fashion between an expanded condition and a collapsed, bundled condition. Crossed, pivotally connected pairs of struts and hub means pivotally joining said pairs of struts in orthogonally patterned end-to-end relation define modules which are movable between a collapsed condition in which the struts are in bundled, generally parallel relation and an expanded condition in which the modules are of three dimensional form. The expanded framework defines a top central portion and a plurality of separate or separable arch portions extending therefrom downwardly in archwise fashion to terminate in supporting leg modules disposed in supporting leg positions in peripherally spaced relation around the base of the framework. Each arch portion comprises at least one string of modules sharing common ends and corresponding hub means with the arches being disposed such that planes passing through the respective opposite sides of the modules of each arch portion intersect planes passing through the opposite sides of the modules of the respective other arch portions. The framework is movable between its expanded and collapsed conditions by moving the supporting leg modules outwardly beyond their supporting leg positions and then back to or through their supporting leg positions. More particularly, in moving the framework from collapsed condition to the expanded condition, the supporting leg modules are moved outwardly from the bundled relation to beyond their supporting leg positions and then back into their supporting leg positions, whereas when moving the framework from expanded to collapsed condition, the supporting leg modules are moved outwardly beyond their supporting leg positions and then back to and past their supporting leg positions into their bundled positions.

Because of the separate arch portions described above, the sequence involved both in collapsing and expanding is wholly different from that which is involved in my prior patents. In my prior patents, the framework is constructed so that its base expands to a maximum dimension. Thus, in order to allow expansion and collapse, there must be at least one girthwise zone of sliding or limited sliding connections at strut pair crossing points in the structure. Thus in my '808 patent, one zone of sliding at strut pair crossings is disclosed whereas in my '313 patent, alternate zones of pivoting and sliding are disclosed. As noted, according to this invention, no sliding zone or zones are required at all and all crossing points of strut pairs may be pivoted without interfering with the collapsing or expanding of the structure. This allows a maximum of strength for the structure when it is expanded.

In order to collapse or to expand, structures of the present invention are provided with base-to-top region separations between those arch portions which extend in different directions from the top central region. In this fashion, when collapsing the structure, the "legs" of the structure defined by these arch portions are moved outwardly (i.e., the base of the structure is further expanded) to commence the substantially simultaneous collapse of all of the modules, until a maximum expansion of the base has occurred and the "legs" then begin to retreat radially inwardly toward each other until, finally, all of the struts of the assembly have assumed a generally parallel, bundled relation with respect to each other. For expanding the structure, the reverse sequence is followed. In either case, the movements of the legs reaches a maximum beyond the normal expanded positions thereof and, at this point, the entire structure is ready to be manipulated either to expanded or collapsed condition. The girthwise sequence of modules which form the lower parts of the "legs" are perpendicular to the supporting surface for the assembly and are very stable.

Suitable means is employed to hold the framework in expanded condition. This means may be effected by forming modules to be self-supporting in the manner disclosed in any of my prior patents 3,698,808; 4,026,313; 4,290,244; and 4,437,275, all of which are incorporated herein by reference. Alternatively, locking link means such as disclosed in the Derus Reissue patent Re. 31,164 may be employed, with or without the face links also employed in that patent, the subject matter of which is also incorporated herein by reference. Other and different means for holding the framework in expanded condition may also be employed as, for example, split hub locking as is disclosed in my prior patent 4,473,986, the subject matter of which is incorporated herein by reference. Another form of locking which may be used is that as described in the Alphonse et al patent 4,479,340, the subject matter of which is also incorporated herein by reference. The hub means preferred in this invention are those of the ring and blade type as disclosed in my prior patent 4,280,251 which is also incorporated herein by reference.

A preferred embodiment of this invention is characterized in that each module of the assembly is self-contained in the sense that each is self-supporting in the expanded or erected condition of the assembly. By self-supporting is meant that each module when expanded attains a "locked" configuration by virtue of the asymmetrical geometry of that

module. The necessary and sufficient condition for self-supporting of each module is that for each pair of inner and outer hubs around the periphery of the module, the sum of the distances from an inner hub along a strut extending therefrom, to the pivoted crossing point with a strut extending from the corresponding outer hub is the same, but that the individual components of the sum are not equal for those struts which extend from these inner and outer hubs toward the center of the module (i.e., the asymmetry condition). This inequality of individual components leads to the condition in which the plane passing through the pivoted crossing points of these centrally extending strut pairs does not lie at the neutral or non-locking position between the planes passing through the inner and outer hubs respectively. This form of module is preferred because, although it adds weight to the framework, each module is inherently stronger and more rigid than otherwise.

Other and further objectives of this invention will be apparent as the following detailed description proceeds.

BRIEF DESCRIPTION OF THE DRAWING FIGURES

Figure 1 is a side elevational view of a shelter framework of an embodiment of the invention;

Figure 2 is a plan view of the framework of Figure 1;

Figure 3 is a vertical section taken along the plane of section line 3-3 in Figure 2;

Figure 4 is a schematic view similar to Figure 3 but showing a simplified form of framework in its maximum base dimension condition;

Figure 5 is a schematic view similar to Figure 4 but showing a retreating position of the framework;

Figure 6 is a perspective view of one of the vertically disposed modules;

Figure 7 is a top plan view of the module of Figure 6;

Figure 8 is a perspective view of a transition module;

Figure 9 is a side elevational view of the module of Figure 8;

Figure 10 is a schematic sequence illustrating a basic rhombicuboctahedron and one sequence of changing the pattern of modules to achieve different forms of frameworks; and

Figure 11 is a schematic sequence similar to Figure 10 but illustrating other pattern changes.

With reference at this time to Figure 2 wherein a top plan view of one form of the invention is illustrated, the top, central portion of the expanded framework shown is seen to be of module form circumscribed by crossed, pivotally connected pairs of struts indicated generally at 10, 12, 14 and 16, in which the ends of the pairs of struts are pivotally joined by hub means later identified in detail. In this particular embodiment, these circumscribing pairs of struts are shared in common with the bounding transition modules 18, 20, 22 and 24 which, as seen better in Figure 1, are end-connected to the vertically disposed modules 26, 28, 30 and 32. As shown in Figure 1, the crossed pair of struts 14 defining one side of the top central region module and shared in common with the transition module 22 comprise the strut 34 and the strut 36 which are of equal lengths and are pivotally connected at their centers by the pivot pin or rivet 38. The strut 34 is pivoted at one end to the hub means 40 and at its other end to the hub means 42'. The strut 36 is pivoted at one end to the hub means 40' and at its other end to the hub means 42. It will be understood that the hub means are preferred to be of the general ring and blade form described in detail in my prior patent 4,280,251 and that by equal length struts is meant that the distance between the ring holes in the blades at opposite ends of a strut is a fixed distance.

Similarly, the two struts forming the pair 10, i.e., the struts 48 and 50, are pivotally connected at their mid-points by the pivot pin means 49 and are respectively pivotally connected to the hub means 44 and the hub means 46' underlying the hub means 46 (see Figure 3) and the hub means 46 and the hub means 44' underlying the hub means 44. Likewise, the struts 52 and 54 forming the pair 12 are respectively pivotally connected at their ends to the hub means 42 and 44'. Lastly, the two struts 56 and 58 forming the pair 16 are pivotally connected at their mid-points by the pivot pin means 57 and are respectively pivotally connected at their ends to the hub means 40 and 46' and to hub 40' and 46.

For ease of indentification, the convention which will be used herein with respect to the various hub means is that all hub means which are on the outer side of the framework will be identified by respective reference characters whereas their corresponding inner hub means will be identified by corresponding primed reference characters. Thus, with respect to the corners of the various modules in Figures 1-3, the eight hub means of the transition module 20 are identified by the reference characters 42, 42'; 44, 44'; 60, 60'; and 62, 62'. The eight hub means associated with the corners of the transition module 18 are the hub means 44, 44'; 46, 46'; 64, 64'; and 66, 66'. Likewise, the eight corners of the transition module 22 are associated with the hub means 40, 40'; 42, 42'; 68, 68'; and 70, 70'. Finally, the eight corners of the transition module 24 are associated with the hub means 40, 40'; 46, 46'; 72, 72'; and 74, 74'.

In the embodiment illustrated in Figures 1-3, the transition modules effect a 90° transition between the horizontally disposed top central region of the framework and their corresponding vertical modules. For this purpose, the opposite pairs of crossed, pivoted struts are asymmetrically disposed with respect to the pivot pins or rivets pivotally connected them. This is evident in Figure 1, for example, wherein it will be seen that for the near pair 80 of crossed struts, the equal length struts 82 and 84 are pivotally connected by the pivot pin 86 such that the length along the portion of the strut 82 from the hub means 42 to the pivot pin 86 is longer than is the distance from the pivot pin 86 to the hub means 62'. As is disclosed in my prior patent 3,968,808, the necessary and sufficient condition for allowing

the framework to collapse into a bundle of generally parallel struts and to be expanded to its three dimensional form is that for each corresponding pair of inner and outer hub means, the sum of the distance along one strut of a pair of crossed, pivotally connected struts from its pivotal connection with an outer hub means to the pivoted connecting point between that pair of struts plus the distance back along the other strut of the pair from that pivoted connecting point to the pivotal connection of that other strut with its corresponding inner hub is a constant. To illustrate, the sum of the distance along the strut 82 from its pivotal connection with the hub means 42 to the pivot pin 86 plus the distance from the pivot pin 86 back along the strut 84 to its pivotal connection with the hub means 42' is a constant and is equal to the sum of the distance along the strut 36 from its pivotal connection with the hub means 42 to the pivot pin 38 plus the distance from the pivot pint 38 back along the strut 34 to its pivotal connection with the hub means 42', and so forth. It is evident that this rule requires that this sum is equal to the length of a single strut of the pairs of struts circumscribing a module so that all such circumscribing struts are of equal length. Since the modules of the framework share common strut-defined sides, it fol lows that a single strut length is employed for all struts which circumscribe the modules, whether the module is of the flat type or of the transition type. For the flat modules, each pair of circumscribing struts are pivoted at their mid-points and for the transition modules, the pairs of struts at opposite ends of the module are also pivoted at their midpoints but along the opposite sides of the transition modules, the struts are not pivoted at their midpoints.

Thus, in the particular embodiment illustrated in Figures 1-3, the lengths of all struts which form strut pairs circumscribing the various modules is the same. Thus, the module defining the top central region is of square plan view as are all the vertically oriented modules. On the other hand, all of the transition modules have opposite sides of trapezoidal shape and opposite ends which are of rectangular shape, the planes passing through the crossed struts at the opposite ends of the transition modules intersecting at an angle of 90° so as to effect the aforesaid transition from the horizontally disposed top central region to the upper ends of the vertically disposed modules. The planes passing through the opposite sides of the transition modules are parallel as are the planes passing through the opposite sides of the vertically oriented modules. Likewise, the planes passing through the opposite ends of the vertically oriented modules are parallel to each other.

A single transition module 20 of this embodiment of the invention is illustrated in perspective in Figure 8 and in elevation in Figure 9.

Thus, the transition modules are characterized by the fact that their inner face portions are rectangular but of a shape different from the rectangular shape of their outer face portions. In the case of the vertically disposed modules, their inner and their outer face portions are of the same rectangular shape and are, moreover, square.

Moreover, each string of modules such as the end-connected modules 32 and 24 forms an arch portion of the framework and each such arch extends from the top central region downwardly, in archwise fashion, from the top central region in a different direction. Thus, from the base of the framework as is defined by those ends or hub means of the vertically disposed modules which engage the supporting surface G, the framework is split from the base to the peak or top central region. This separation between arches which extend in different directions from the top central region allows the framework to collapse or to expand in the fashion illustrated in Figures 4 and 5 as is later described.

Returning now to Figures 1-3 to complete the description of the assembly shown therein, the struts 90 and 92 of the pair of crossed, pivotally connected struts defining the far side of the transition module 20 are asymmetrically pivoted by the pivot pin 94 in the fashion previously described for the near side struts 82 and 84. The strut 90 is pivotally associated with the hub means 60 and 44' whereas the strut 92 is pivotally associated with the hub means 44 and 60'. The remaining end side of the transition module 20 is defined by the crossed, pivotally connected pair of struts 96 and 98 which are centrally pivoted together by the pivot pin 100, in the same fashion that the opposite end struts 52 and 54 are centrally pivoted by the pivot pin 55. Thus, for a transition module such as 20, the opposite ends are each defined by a pair of crossed, pivo tally connected struts wherein the pivot pin is located at the centers of the struts and the planes passing through such ends intersect at a right angle whereas its opposite sides are each defined by a pair of crossed, pivotally connected struts in which the pivot pin is located asymmetrically along the struts and the planes passing through these sides are parallel. On the other hand, the opposite ends as well as the opposite sides of the other modules such as the module 28 are each defined by a pair of crossed, pivotally connected struts in which the pivot pin is located centrally of the struts and the planes passing through the respective sides as well as the planes passing through the opposite ends are parallel. One such module 28 is illustrated in larger scale in Figures 6 and 7.

As shown in Figure 6, the two struts 96 and 98 defining one end of the transition module 20 are shared with the module 28, as are the several hub means 60, 60' and 62, 62'. One side of the module 28 is defined by the crossed, pivotally connected pair of struts 110 and 112 which, like the struts 96 and 98, are pivotally connected at their centers by the pivot pin 114. The strut 110 is pivotally connected at one end to the hub means 62 and at its opposite end to the hub means 116' whereas the strut 112 is pivotally connected at one end to the hub means 62' and at its other end to the hub means 116. At its bottom end, the module 28 is defined by the crossed, pivotally connected pair of struts 118 and 120 which are pivotally joined at their centers by the pivot pin 122. The strut 118 is pivotally connected at one end to the hub

means 116 and at its opposite end to the hub means 124'. The strut 120 is pivotally connected at one end to the hub means 116' and at its other end to the hub means 124. Lastly, the other vertical side of the module 28 is defined by the pair of crossed, pivotally connected struts 126 and 128 whose centers are connected by the pivot pin 130. The strut 126 is pivotally connected at one end to the hub means 124 and at its opposite end to the hub means 60'. The strut 126 is pivotally connected at one end to the hub means 124 and at its opposite end to the hub means 60'. Thus, all the sides and ends of the module 28 are the same and this holds true for all other modules of this embodiment of the invention except for the transition modules.

Inasmuch as the circumscribing ends/sides of all similar modules are the same, no further description of the sides and ends of the other transition modules 18, 20, 22 and 24 or of the other modules 26, 30 and 32 and the module defined at the top central region by the circumscribing ends of the transition modules will be given. However, it should be noted that the circumscribing struts are woven in a preferred pattern around each module. This weaving is readily seen in Figure 6. One way of stating the preferred rule is that if a strut such as 112 is placed outside its associated strut 110, then the next successive strut 96 should be placed inside its associated strut and so on. That is, the next successive strut 128 in the sequence of struts 112, 96, 128 and 118 would be outside its associated strut 126 and, lastly, the strut 118 would be inside its associated strut 120. This weaving pattern distributes the bending actions on the struts evenly while assuring that the inner and outer hub means are in spaced registry with each other when the framework is expanded.

Although the means for holding the framework in the expanded condition has not as yet been described for Figures 1-3, it is well at this point to describe the cooperation among the components during manipulation of the framework between collapsed and expanded conditions. For this purpose, a simplified form of framework is illustrated in Figure 4 and 5, to which reference is now had.

From these Figures, it will be seen that the simplified form of the framework is identical with that described in connection with Fig-res 1-3 except that the self-locking central struts for each module (which are to be described later) are not employed. Thus, the flat modules 14, 28 and 32 are readily seen as well as the transition modules 20 and 24. The various hub means and struts described above in Figures 1-3 are also illustrated and additional hub means 125 and 125' as well as struts 126 and 127 of the module 32 and the pivot pin means 128 which pivotally connects them at their mid-points and struts 130 and 132 of the module 24 and the pivot pin means 134 which pivotally connects them in offset relation to their mid-points. Figure 4 illustrates approximately the maximum position of the framework in making the transition either to e expanded condition or to the collapsed condition. The arch portions defined by the modules 28 and 20 and by the modules 24 and 32 are flattened in comparison with their positions in Figures 1-3. Furthermore, all of the modules throughout the framework are in partially collapsed condition. Thus, the depth of each module is greater than its depth in the fully expanded condition, as will be readily evident from comparison between Figures 3 and 4. The position of Figure 4 is attained by moving all of the arch portions outwardly as previously described. Thus, with reference to Figure 2, the arch portion defined by the modules 20 and 28 and the arch portion de fined by the module 24 and the module 32 are moved away from each other whereas the arch portion defined by the module 18 and the module 26 and the arch portion defined by the module 22 and the module 30 are moved away from each other. This should be done in as uniform and simultaneous fashion as is reasonably possible. When it is done manually, as is feasible when the weight of the framework and its covering is such that no difficulty is had for four persons to lift the entire assembly off the supporting surface, one person is positioned at each of the four arch portions and the respective four modules 28, 30, 32 and 26 are grasped and the assembly lifted. Then the persons involved move their respective modules as aforesaid until the position of Figure 4 is reached. At this time, all of the modules of the framework are partially collapsed and they will tend to collapse further under the weight of the framework, exerting inward pulling forces which are readily perceived by the persons holding the framework. If, as described at this time, the framework is being moved from expanded condition to collapsed condition, the persons involved merely respond to the inward pulling forces and move their modules inwardly as is indicated in Figure 5. Finally, the modules are pushed inwardly until the bundled, collapsed condition is reached.

Starting from the collapsed condition, the four persons involved again grasp their respective modules 28, 30, 32 and 26 and after lifting the framework assembly, they move their respective modules outwardly until the Figure 4 position is reached. Now, in order to manipulate the framework assembly to the expanded condition, it is necessary not only to move the grasped modules inwardly but also to urge the framework assembly simultaneously toward the expanded condition. This may be done in any way which is convenient. Perhaps the easiest way is for the four persons each to manipulate the module they are holding towards its expanded condition as such module is being moved inwardly. Other and different techniques may of course be used as, for example, a fifth person could push upwardly on the framework from the interior, etc.

The particular technique employed may depend in large part upon the type of framework involved. For example, if the framework assembly is of the self-locking module type illustrated in Figures 1-3, the transition toward the expanded condition from the Figure 4 condition is more difficult than is the case for the modified form of the framework, without the self-locking modules, of Figures 4 and 5. In fact, for the framework type as in Figures 4 and 5, very little effort is required to urge the assembly toward the expanded condition as the modules are moved inwardly from the Figure 4 position.

Once the framework assembly has been moved to the expanded condition, it will self-lock in the expanded condition if the modules, or some of the modules are of the self-locking type. If no self-locking of the framework modules is employed, extraneous locking is normally desirable. However, it should be noted that the flexible covering material as disclosed in my prior patents will aid in holding the framework assembly is expanded condition. That is, in moving from the Figure 4 condition to the expanded condition, the covering material will become taut as the modules reach a maximum of expansion, and it will thus limit the expanded condition of each module. In some cases, this is sufficient to retain the framework assembly in the expanded condition, bearing in mind also that with the modules 28, 30, 32 and 26 resting in contact with the supporting surface, a substantial degree of stability is derived therefrom.

However, it is also to be noted that extraneous locking means may also be employed as may be necessary and that such extraneous locking means may take any desired form such as is described in my prior patent 4,473,986; the Derus reissue patent Re. 31,641; the Alphonse et al patent 4,479,340 or the like. In fact, any extraneous locking, holding or anchoring means may be employed, as is desired.

For maximum rigidity and strength, however, the preferred configuration resides in the provision of self-locking module configurations and these are easily implemented in accord with the teachings of my prior patents. Thus, referring to Figures 6 and 7, each flat module means may employ the central strut structure therein and which will now be described.

Although Figures 6 and 7 illustrate the particular flat module 28, it will be understood that any and all flat modules within the framework may take this form. As illustrated, the outer and inner hub means 140 and 140' are provided. The blades at the inner ends of the struts 142, 144, 146 and 148 are pivotally connected with the ring of the hub means 140 (see my prior patent 4,280,521) whereas the blades at the inner ends of the struts 150, 152, 154 and 156 are pivotally connected with the ring of the hub means 140'. Likewise, the blades at the outer ends of the struts 142, 144, 146 and 148 are connected pivotally with the rings of the respective hub means 60', 124', 116' and 62'. The set of struts 142, 144, 146 and 148 are of the same length but are longer than the struts of the set 150, 152, 154 and 156. It will be noted that pairs of struts of the two sets are in crossed, pivoted relation, i.e., they constitute scissored pairs of struts. Thus, the pair of struts 142 and 150 is pivotally connected by the pivot means 160; the pair of struts 144 and 152 is pivotally connected by the pivot means 162; the pair of struts 146 and 154 is pivotally connected by the pivot means 164; and the pair of struts 148 and 156 is pivotally connected by the pivot means 166. The lengths of the struts of the two sets are chosen so that two conditions are met. First, the previously described necessary and sufficient condition for movement between the collapsed condition and expanded condition must be followed. That is, for each pair of inner and outer hub means such as the hubs 62 and 62', the distance along the strut 156 from its pivotal connection with the hub means 62 to the pivot point at 166 plus the distance along the strut 148 from the pivot point at 166 back to its pivotal connection with the hub means 62' is the previously described constant which is equal to the length of a circumscribing strut between its end pivotal points. Second, the necessary and sufficient condition for self-locking must be followed. This necessary and sufficient condition is that a plane passing through the pivot means 160, 162, 164 and 166 must be offset from the plane passing through the pivot means 100, 130, 122 and 144. This is evident from Figure 7. If these two planes are coincidental, i.e., are one and the same plane, a "neutral" condition prevails and no self-locking action is attained. On the other hand, the more the plane passing through the pivot means 160, 162, 164 and 166 is offset from the plane passing through the pivot means 100, 130, 122 and 114 toward the ultimate position in which such plane also passes through the set of hub means such as the hub means 60, 62, 116 and 124, and stronger the self-locking action becomes. Because the forces of self-locking generated become larger as the ultimate position is approached, it is preferred to soften the self-locking action to some degree by choosing the lengths of the struts of the two sets such that the struts 150, 152, 154 and 156 each lie at a small angle (in the order of 3°-7°) to the plane passing through the hub means 60, 62, 124 and 116.

With reference to Figures 8 and 9, the same general principles for self-locking as described above for Figures 6 and 7 prevails. The central struts in this case are the set of struts 170, 172, 174 and 176 and the set of struts 180, 182, 184 and 186. The central outer and inner hub means are 178 and 178'. The scissored crossing point are at the pivot means 190, 192, 194 and 196. As noted before, the length of each circumscibing strut such as the strut 52 is of the same length as that of all the other circumscribing struts of all other modules, i.e., the length of the strut 52 in Figures 8 and 9 is the same as the length of the strut 98 in Figures 6 and 7. Similarly, it is the case that the length of each strut such as the strut 154 in Figures 6 and 7 is the same as the length of each strut such as the strut strut 184 of Figures 8 and 9. Likewise, the length of each strut such as the strut 146 of Figures 6 and 7 is the same as the length of each strut such as the strut 174 of Figures 8 and 9. Thus, only three different length struts need be used throughout the entire framework assembly, thus greatly simplifying fabrication.

Figures 10 and 11 illustrate how different patterns of modules may be employed to achieve an infinite variety of framework configurations with independence among height, width and length.

In Figure 10, a basic rhombicuboctahedron is indicated at 200. From the perspective angle of the Figure, only seven faces of the rhombicuboctahedron are seen. However, there are in reality twenty six faces to this body. What is illustrated are the faces which will be termed herein as the top central face 202, the two transition faces 204 and 206, the girthwise faces 208, 210 and 212, and the triangular

(equilateral) face 214. Girthwise of the rhombicuboctahedron, there are five more faces in addition to the three faces 208, 210 and 212 illustrated; in the transition region there are two more transition faces in addition to the transition faces 204 and 206 illustrated and three more triangular faces in addition to the triangular face 214 illustrated. The four transition faces plus the four triangular faces and the top central face constitute the top pyramid of the body. On the bottom pyramid which is not seen, there is a bottom central face corresponding to the face 202 and all of the faces corresponding with the top pyramid transition faces and the top pyramid triangular faces, a total of twenty six faces in all, eight girthwise faces, two central region faces, eight transition faces and eight triangular faces. From the form of the invention illustrated in Figures 1-3, it will be seen that the expanded module 30 defines the girthwise face 208, the expanded module 28 defines the girthwise face 212, the expanded module 14 defines the top central face 202, the expanded module 22 defines the transition face 204 and the expanded module 20 defines the transition face 206. Further, it will be seen that the expanded module 32 defines the girthwise face opposite the girthwise face 212, the expanded module 26 defines the girthwise face opposite the girthwise face 208, the expanded module 24 defines the transition face opposite the transition face 206 and the expanded module 18 defines the transition face opposite the transition face 204.

It will also be evident from Figure 1-3 that all of four of the girthwise faces corresponding to the girthwise face 210 in Figure 10 are left open as entrances for the shelter assembly. Similarly, none of the four triangular transition faces corresponding with the triangular transition face 214 of Figure 10 is defined by any modules in Figures 1-3. In addition, the entire bottom pyramid is not used.

At this time, however, it should be noted that other and different configurations than is illustrated in Figures 1-3 may be employed for the basic rhombicuboctahedron. Before discussing these possibilities in detail, it should be pointed out that whereas the basic rhombicuboctahedron is a regular solid having eighteen square faces and eight triangular faces, the frameworks of this invention involve modules which define only four girthwise square faces and no transition faces which are either square or of equilateral form. To illustrate, the four modules 26, 28, 30 and 32 all define when expanded four square girthwise faces. However, if the framework also includes a module which corresponds, say, with the girthwise face 210 of Figure 10, such module will be transition module such as that illustrated in Figures 8 and 9 (i.e., a module such as 20) but which has been rotated 90° as explained in more detail hereinafter. Thus, such a girthwise transition module will define a rectangular girthwise face rather than a square girthwise face as illustrated at 210 in Figure 10.

The use of such a further girthwise module is indeed desirable because it not only defines a girthwise face which is at an angle to any flat module adjacent to it and which defines another girthwise face, but it also cooperates with other modules in the framework assembly to complete the triangular face at the corresponding corner of the top central face or region. This lends greater rigidity to the framework when expanded. Indeed, when all four girthwise faces such as 210 are employed, an extremely rigid structure is formed because the top central region is bounded and circumscribed completely by transition modules so that in any vertical section, a deep truss-like structure is present.

Thus, one possibility of modifying the basic rhombicuboctahedron from the form illustrated in Figure 1-3 is to omit, say, the two girthwise modules 26 and 30 and add four girthwise transition modules. Such a configuration, referring to Figure 1 at this time, would omit all of the central or self-locking struts 220 as well as the scissored pairs of struts 21, 226 and 228 and the hub means 222 and 224 as well as their corresponding inner hub means as indicated in Figure 1 but would retain the two pairs of hub means 68, 68' and 70, 70' as well as the scissored pair of struts 219. A transition module such as the module illustrated in Figures 8 and 9 could be added as follows. The two hub means 44 and 44' of Figure 8 would lie adjacent the positions of the hub means 68, 68' of Figure 1 with the pair of scissored struts 52 and 54 of Figure 8 extending vertically and the hub means 42 and 42' of Figure 8 lying adjacent the positions of the removed hub means 222 and its corresponding inner hub means of Figure 1 with the two struts 82 and 84 of Figure 8 extending to the hub means 116 and 116' (i.e., the hub means 62, 62' of Figure 8 become the hub means 116, 116' of Figure 1) and the hub means 60, 60' of Figure 8 become the hub means 62, 62' of Figure 1 and the two struts 96 and 98 of Figure 8 becoming the struts 110 and 112 of Figure 1.

Of course, the three remaining transition modules to be added would be similarly arranged in the pattern of modules. It is to be noted that a transition triangular face would be defined at each corner of the top central module or region 14 to provide the complete bounding or circumscribing of this top central region to provide the truss-like relationship previously described. Although not essential, the added transition modules may be manually joined to a corner of an adjacent transition module for increased rigidity. That is, with relation to the added transition module described above, the hub means 44, 44' of Figure 8 may be manually joined to the hub means 68, 68' of Figure 1. Since the framework must be separate or separable from the base of the framework upwardly to the top central region, and especially to the corners of the top central region, if manual joining of the hub means is employed, such joining must be removed before the framework is collapsed.

Such joining is especially important in lending rigidity to the framework if the modules are not of the self-locking type and omit the central struts, employing only the circumscribing pairs of struts. With such a configuration, with four added transition modules as above, the manual joining in and of itself is sufficient not only to lock the framework in expanded condition but also lends such increased rigidity thereto as does not require any further lock-

ing, especially since the fabric itself lends stability to the structure.

It will be apparent that additional configurations may be made as, for example, by omitting only one of the girthwise modules in Figure 1.

Returning to Figure 10, on the right-hand side thereof as indicated by the arrow, an infinite variation of the module patterns may be made. The seven faces illustrated at the left-hand side of Figure 10 are identified in the right-hand side as well and it will be seen that addition of transition modules may be made in any one or a combination of orthogonal directions from the triangular face 214. Thus, one or more transition modules 204', 206' or 210' may be added independently to increase the length, width or height of the shelter structure. Obviously, when a transition module 206' is added, the area of the top central region is correspondingly increased as noted by the additions 214'. Similarly, as transition modules 204' are added, the area of the top central region is increased as noted by the additions 214". As transition modules 210 are added, as noted by the module 210', corresponding girthwise modules 208' and 212' must be added. Thus, to increase the shelter length, transition modules 206' are added with corresponding increase in the area of the top central region as at 214'. To increase the shelter width, transition modules 204' are added with corresponding increase in area of the top central region as at 214". Lastly, to increase the height of the structure, transition modules 210' are added with corresponding additions of the girthwise modules 208' and 212'. Therefore, width, height and length may be controlled independently or in concert. Further, girthwise modules including not only the modules 208 and 210 but also the modules 210 may be omitted from the pattern as desired. The top central region need not be filled in with module structures inasmuch as such addition of structure lends minimal additional rigidity and principally serves only to add weight to the structure, a feature not usually desirable.

Figure 11 illustrates another possibility for controlling the shape or dimensions of the structure. In this case, however, the central portion of the Figure as indicated by the first arrow illustrates the simultaneous additions of all three transition modules 204, 206 and 210. The original faces 208 and 212 are preserved in this technique, as is the original top central region 202.

As indicted by the second arrow in Figure 11, a combination of the two techniques of Figures 10 and the central portion of Figure 11 yields still another possibility. It will be appreciated that the technique of Figure 10 tends toward a cubic or rectangular polyhedral form whereas the technique of the central portion of Figure 11 tend toward an octahedral form and, lastly, the technique of the right-hand side of Figure 11 tends toward enlargement of the rhombicuboctahedral form.

The covering material made be made of one piece and may include flaps with zipper or similar edge connections means for covering any openings or the like. Preferably, the covering material is attached to the framework at the hub means in the manner disclosed in any one of my prior patents and in order to allow the arch portions of the framework to separate for expansion or collapsing, the covering is also provided for such separation, even though it may be zipped up to effect the proper covering function when the framework is expanded.

Claims

1. A framework for a portable shelter, said framework comprising a plurality of pivotally interconnected elongate struts (e.g. 10, 12, 14, 16) capable of relative movement between an expanded condition defining a network of modules forming a three dimensional framework and a collapsed condition defining bundled struts, each module being of three dimensional form when the framework is expanded and each module including opposite ends each formed by a pair of crossed, pivotally connected struts and oppositie sides each formed by a pair of crossed, pivotally connected struts, and hub means (e.g. 40, 42') pivotally joining adjacent ends of said pairs of struts, characterized in that when the framework is expanded, a said first set (26, 28, 30, 32) of said modules are bounded by opposite sides and opposite ends in which the crossed, pivoted pairs of struts defining such sides and ends are symmetrically crossed and pivoted and a second set (18, 20, 22, 24) of said modules are bounded by opposite sides and opposite ends in which the opposite sides of the modules of said second set are defined by pairs (e.g. 80) of struts (82, 84) which are asymmetrically crossed and pivoted (86) and in which the opposite ends of the modules of said second set are defined by parts of struts (e.g. 96, 98) which are symmetrically crossed and pivoted (100) said first set and said second set of modules forming a plurality of strings of modules extending downwardly from the upper portion of the framework, each string of modules defining a separate arch portion for supporting the upper portion in elevated position.

2. A framework as defined in claim 1 wherein the upper portion (14) is square or rectangular and adjacent arch portions define separations therebetween at the corners of the upper portion.

3. A framework for a portable shelter as defined in claims 1–2 wherein all of said struts are of the same length.

4. A framework for a portable shelter as defined in claims 1–3 wherein said upper portion is provided on all sides with at least one arch portion.

5. In a collapsible/expandable framework as defined in claims 1–4 including flexible material joined to said framework in covering relation thereto.

6. In a collapsible/expandable framework as defined in claims 1–5 wherein said first set of said modules (e.g. 28) when expanded present inner and outer faces which are square and said second set of said modules (e.g. 20) when expanded present inner and outer faces which are of different rectangular areas.

7. In a collapsible/expandable framework as defined in claims 1–6 wherein at least one of said arch portions is defined by a first sequence of said modules arching downwardly from said upper portion

(14) adjacent a corner thereof and a second sequence of said modules joined along a vertically extending edge of said first sequence of modules in alignment with a corner of said top region.

8. In a collapsible/expandable framework as defined in claims 1–7 wherein another of said arch portions is defined by a third sequence of said modules arching downwardly from said top region adjacent said corner thereof, and means separably joining said third sequence to said further sequence in side-by-side relation.

9. In a collapsible/expandable framework as defined in claims 1–8 wherein at least one arch portion is located in bridging relation to one corner of the upper portion to define a triangular module at such corner, and including means for separably joining an apex of said triangular module to an adjacent module.

Patentansprüche

1. Rahmenwerk für ein tragbares Gebäude, welches Rahmenwerk eine Vielzahl von schwenkbar miteinander verbundenen, langgestreckten Streben (z.B. 10, 12, 14, 16) enthält, die in der Lage sind, eine relative Bewegung zwischen einem aufgespannten Zustand, in dem ein Netzwerk von Modulen gebildet wird, die ein dreidimensionales Rahmenwerk bilden und einem zusammengeklappten Zustand durchzuführen, in dem gebündelte Streben gebildet werden, wobei jedes Modul

– von dreidimensionaler Form ist, wenn das Rahmenwerk aufgespannt ist und

– gegenüberliegende Enden enthält, von denen jedes durch ein Paar von gekreuzten, schwenkbar miteinander verbundenen Streben gebildet ist sowie

– gegenüberliegende Seiten enthält, von denen jede durch ein Paar von gekreuzten, schwenkbar miteinander verbundenen Streben gebildet ist und

– Nabeneinheiten (z.B. 40, 42') enthält, die nebeneinanderliegende Enden von besagten Paaren von Streben schwenkbar miteinander verbinden,

dadurch gekennzeichnet, daß im aufgespannten Zustand des Rahmenwerkes ein solcher erster Satz (26, 28, 30, 32) von den besagten Modulen von gegenüberliegenden Seiten und gegenüberliegenden Enden begrenzt ist, bei denen die gekreuzten, schwenkbaren Paare von Streben, die diese Seiten und Enden bilden, symmetrisch gekreuzt und gegenseitig angelenkt sind und ein zweiter Satz (18, 20, 22, 24) von besagten Modulen von gegenüberliegenden Seiten und gegenüberliegenden Enden begrenzt sind, bei denen die gegenüberliegenden Seiten der Module des besagten zweiten Satzes durch Paare (z.B. 80) von Streben (82, 84) gebildet sind, die asymmetrisch gekreuzt und gegenseitig angelenkt (86) sind und bei denen die gegenüberliegenden Enden der Module des besagten zweiten Satzes durch Paare von Streben (z.B. 96, 98) gebildet sind, die symmetrisch gekreuzt und gegenseitig angelenkt (100) sind, wobei der besagte erste Satz und der besagte zweite Satz von Modulen eine Vielzahl von Folgen von Modulen bilden, die sich vom oberen Abschnitt des Rahmenwerkes nach unten erstrecken, wobei jede Folge von Modulen einen getrennten Bogenabschnitt bildet, um den oberen Abschnitt in erhöhter Position zu halten.

2. Rahmenwerk nach Anspruch 1, wobei der obere Abschnitt (14) quadratisch oder rechteckig ist und nebeneinanderliegende Bogenabschnitte dazwischen Trennungen an den Ecken des oberen Abschnittes bilden.

3. Rahmenwerk für ein tragbares Gebäude nach den Ansprüchen 1 bis 2, wobei alle besagten Streben von der gleichen Länge sind.

4. Rahmenwerk für ein tragbares Gebäude nach den Ansprüchen 1 bis 3, wobei der obere Abschnitt an allen Seiten mit zumindest einem Bogenabschnitt versehen ist.

5. Zusammenklappbares/aufspannbares Rahmenwerk nach den Ansprüchen 1 bis 4, das ein flexibles Material beinhaltet, das mit dem Rahmenwerk in abdeckender Beziehung dazu verbunden ist.

6. Zusammenklappbares/aufspannbares Rahmenwerk nach den Ansprüchen 1 bis 5, wobei der besagte erste Satz besagter Module (z.B. 28) im aufgespannten Zustand innere und äußere Flächen bildet, die quadratisch sind und wobei der zweite Satz von den besagten Modulen (z.B. 20) im aufgespannten Zustand innere und äußere Flächen bildet, die verschiedene rechteckige Flächen aufweisen.

7. Zusammenklappbares/aufspannbares Rahmenwerk nach den Ansprüchen 1 bis 6, wobei zumindest einer der besagten Bogenabschnitte durch eine erste Folge der besagten Module gebildet ist, die sich bogenförmig vom obenliegenden Abschnitt (14) bei einer Ecke davon nach unten erstrecken und wobei eine zweite Folge der besagten Module entlang einer sich vertikal erstreckenden Kante der besagten ersten Folge von Modulen in Fluchtung mit einer Ecke des besagten obenliegenden Abschnittes verbunden ist.

8. Zusammenklappbares/aufspannbares Rahmenwerk nach den Ansprüchen 1 bis 7, wobei ein anderer der besagten Bogenabschnitte durch eine dritte Folge von den besagten Modulen gebildet ist, die sich vom obenliegenden Bereich bei einer Ecke davon bogenartig nach unten erstrecken und Mittel, die die dritte Folge mit der weiteren Folge in einer Lagebeziehung Seite-an-Seite trennbar miteinander verbinden.

9. Zusammenklappbares/aufspannbares Rahmenwerk nach den Ansprüchen 1 bis 8, wobei zumindest ein Bogenabschnitt in brückenartiger Lagebeziehung zu einer Ecke des obenliegenden Abschnittes angeordnet ist, um ein dreieckiges Modul an einer solchen Ecke zu bilden und beinhaltend Mittel zum trennbaren Verbinden eines Scheitelpunktes des dreieckigen Modules mit einem danebenliegenden Modul.

Revendications

1. Armature pour abri transportable, ladite armature comprenant une pluralité de barres allongées et reliées de manière pivotante (par exemple 10, 12, 14, 16) pouvant se déplacer relativement entre un état déployé définissant un réseau de modules for-

mant une armature tridimensionnelle et un état replié définissant des barres regroupées en paquet, chaque module étant tridimensionnel lorsque l'armature est déployée et chaque module comprenant des extrémités opposées composées chacune d'une paire de barres croisées et reliées de manière pivotante, et de moyens formant rotule (par exemple 40, 42') joignant de manière pivotante les extrémités adjacentes desdites paires de barres, caractérisée en ce que lorsque l'armature est déployée, un premier parmi lesdits ensembles (26, 28, 30, 32) desdits modules est limité par des côtés opposés et des extrémités opposées, les paires croisées et actionnées de manière pivotante de ce premier ensemble qui définissent ces côtés et ces extrémités étant croisées de manière symétrique et actionnées de manière pivotante et un deuxième ensemble (18, 20, 22, 24) desdits modules est limité par des côtés opposés et des extrémités opposées, les côtés opposés des modules dudit deuxième ensemble étant définis par des paires (par exemple 80) de barres (82, 84) croisées de manière asymétrique et actionnées de manière pivotante (86), les extrémités opposées des modules dudit deuxième ensemble étant définies par des parties de barres (par exemple 96, 98) croisées de manière asymétrique et actionnées de manière pivotante (100), lesdits premier et deuxième ensembles de modules formant une pluralité de chaînes de modules s'étendant vers le bas à partir de la partie supérieure de l'armature, chaque chaîne de modules définissant une partie séparée en arche pour le support de la partie supérieure en position déployée.

2. Armature selon la revendication 1, caractérisée en ce que la partie supérieure (14) est carrée ou rectangulaire et en ce que des parties adjacentes en arche délimitent des séparations entre elles aux coins de la partie supérieure.

3. Armature pour abri transportable selon l'une des revendications 1 et 2, caractérisée en ce que toutes lesdites barres sont de la même longueur.

4. Armature pour abri transportable selon l'une des revendications 1 à 3, caractérisée en ce que ladite partie supérieure comporte sur tous ses côtés au moins une partie en arche.

5. Armature repliable/déployable selon l'une des revendications 1 à 4, caractérisée en ce qu'elle comprend un matériau flexible attaché à ladite armature pour assurer une fonction de couverture de cette dernière.

6. Armature repliable/déployable selon l'une des revendications 1 à 5, caractérisée en ce que ledit premier ensemble desdits modules (par exemple 28), lorsqu'il est déployé, présente des faces internes et externes carrées et en ce que ledit deuxième ensemble desdits modules (par exemple 20), lorsqu'il est déployé, présente des faces internes et externes de surfaces rectangulaires différentes.

7. Armature repliable/déployable selon l'une des revendications 1 à 6, caractérisée en ce qu'au moins une desdites parties en arche est définie par une première séquence desdits modules s'incurvant en arche vers le bas à partir de ladite partie supérieure (14) adjacente à un de ses coins et en ce qu'une deuxième séquence desdits modules est jointe le long d'un bord s'étendant verticalement de ladite première séquence de modules en alignement avec un coin de ladite zone supérieure.

8. Armature repliable/déployable selon l'une des revendications 1 à 7, caractérisée en ce qu'une autre desdites parties en arche est définie par une troisième séquence desdits modules s'incurvant en arche vers le bas à partir de ladite zone supérieure adjacente audit coin de celle-ci, et en ce que des moyens joignent séparément ladite troisième séquence à ladite séquence supplémentaire de manière à ce qu'elles soient côte-à-côte.

9. Armature repliable/déployable selon l'une des revendications 1 à 8, caractérisée en ce qu'au moins une partie en arche est située de telle manière qu'elle sert de pont avec un coin de la partie supérieure pour définir un module triangulaire à l'endroit de ce coin, et comprenant des moyens pour joindre séparément un sommet dudit module triangulaire à un module adjacent.

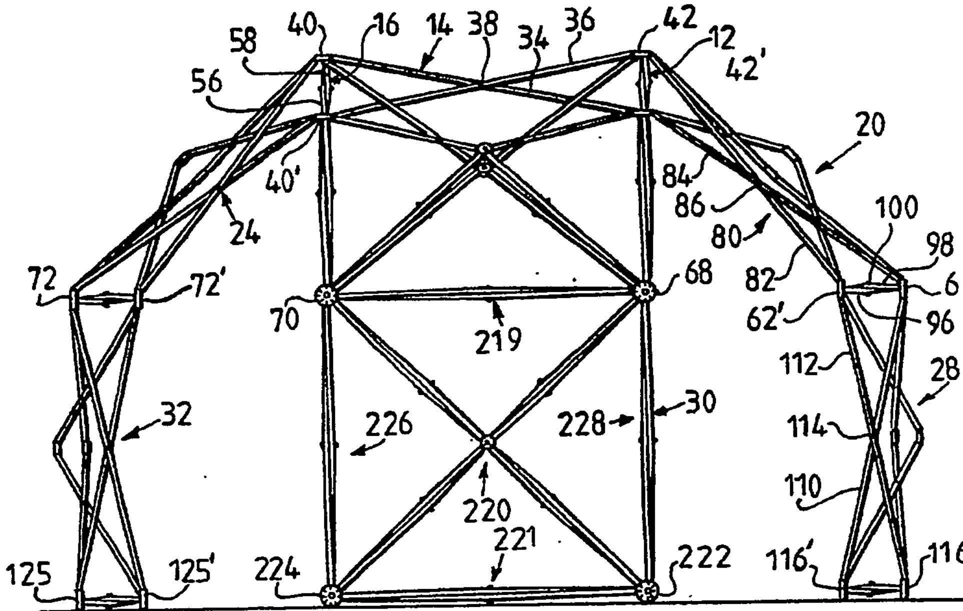
58
40
16
14
38
34
36
42
12
42'
56
40'
20
84
86
24
80
100
98
72
72'
82
68
62
62'
96
70
219
112
28
32
226
228
30
114
110
220
221
125
125'
224
222
116'
116

FIG.1

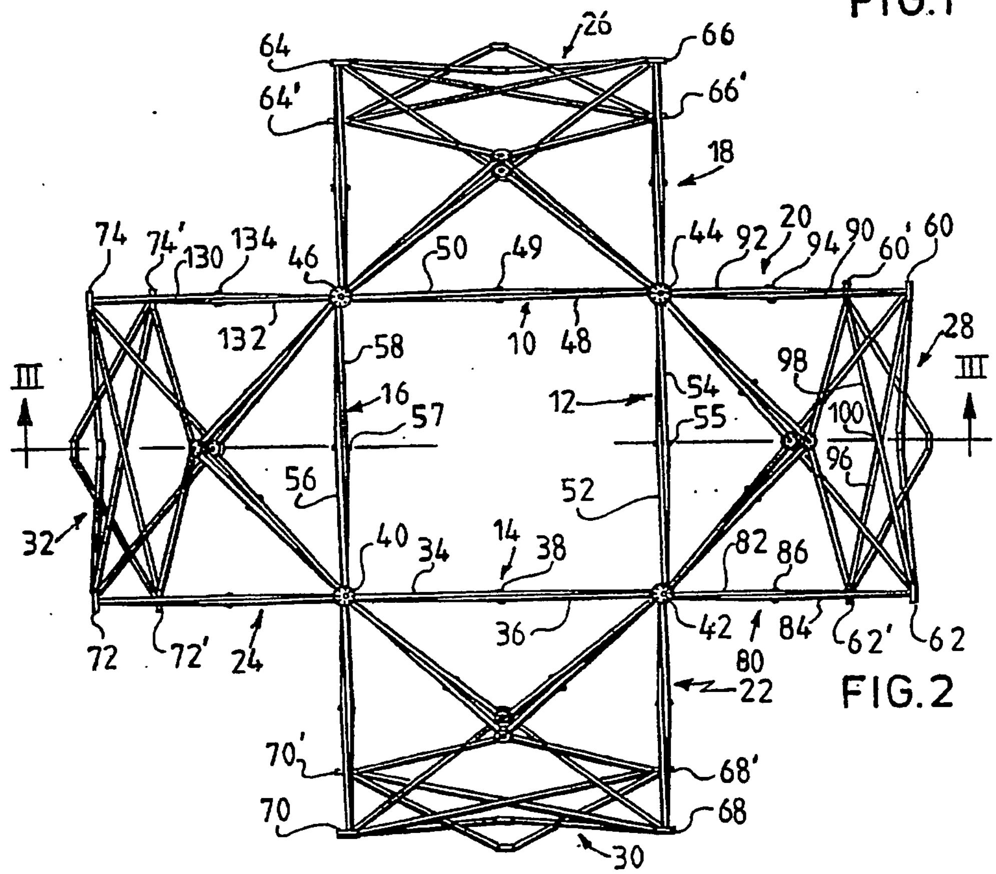
64
26
66
64'
66'
18
74
74'
130
134
46
50
49
44
92
20
94
90
60'
60
132
10
48
28
58
98
III
16
57
12
54
55
100
III
56
52
96
32
40
34
14
38
82
86
72
72'
24
36
42
80
84
62'
62
22
70'
68'
70
68
30

FIG.2

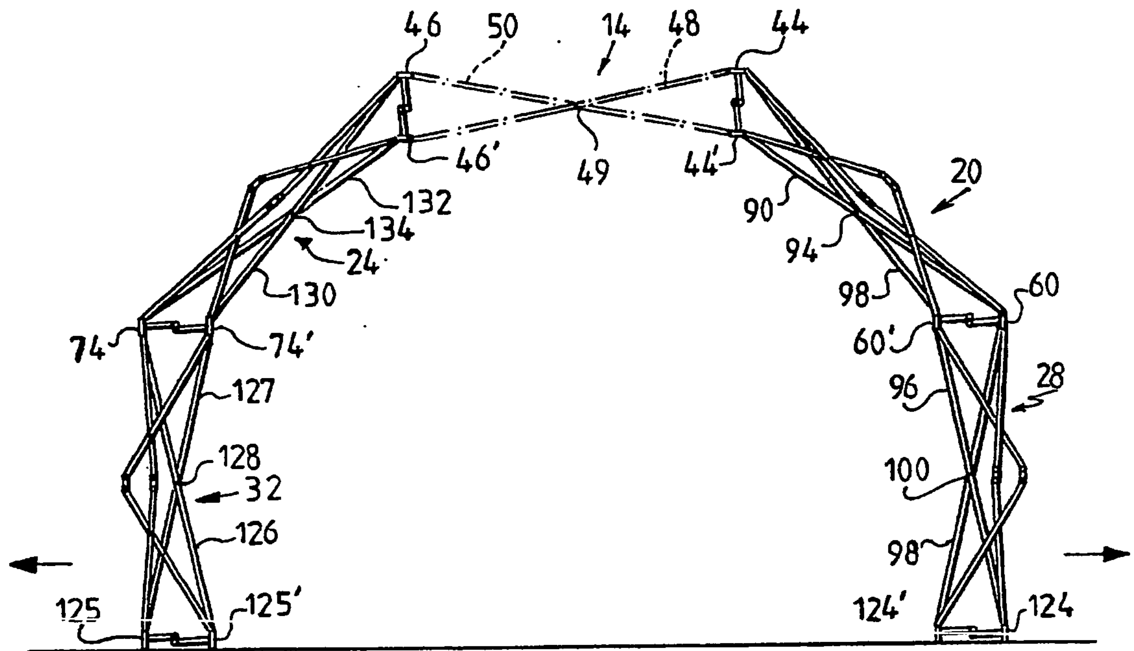

FIG. 3

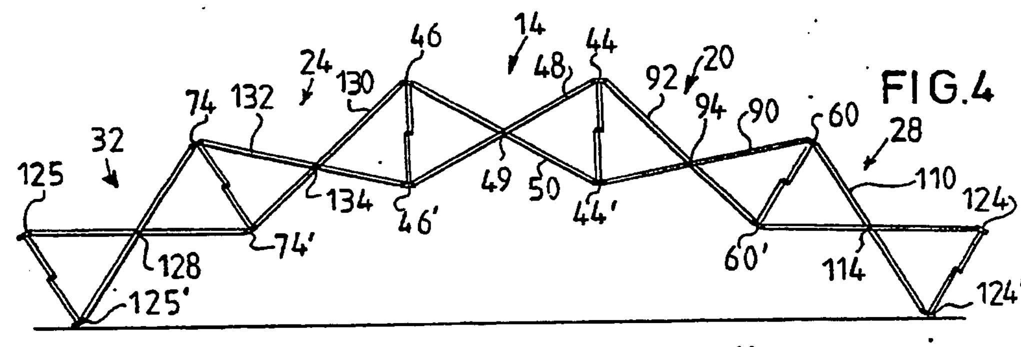

FIG.4

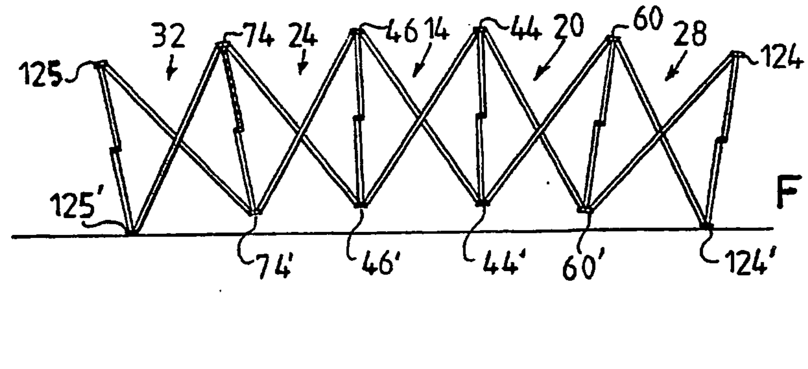

FIG.5

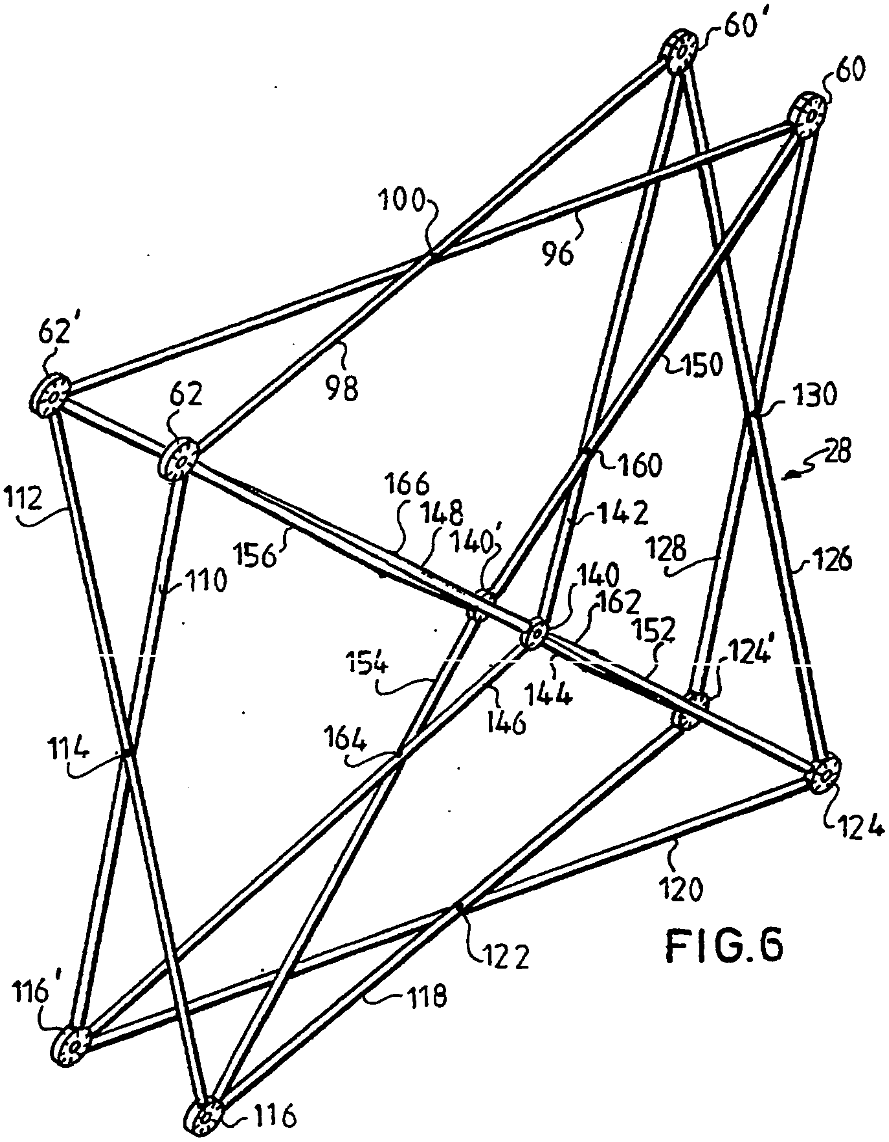
60'
60
100
96
98
62'
62
150
130
28
160
112
166
148
142
156
140'
128
126
110
140
162
152
124'
154
144
146
114
164
124
120
122
116'
118
116

FIG.6

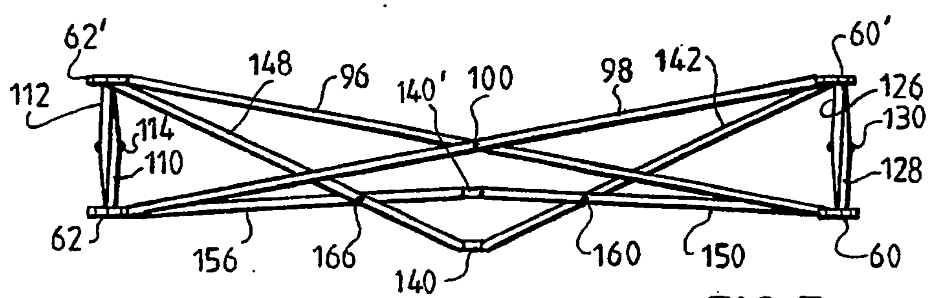
62'
148
96
140'
100
98
142
60'
126
112
114
130
110
128
62
156
166
160
150
60
140

FIG.7

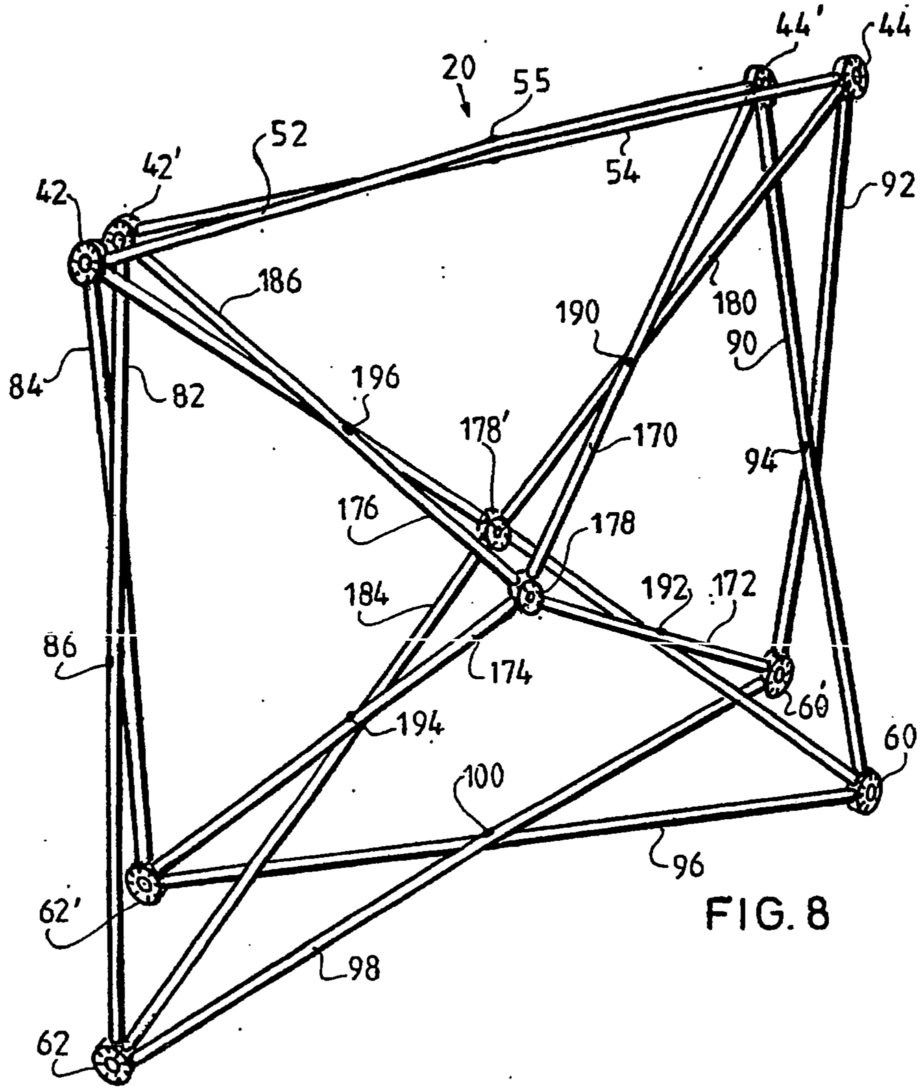
20
55
52
54
42'
42
44'
44
92
186
180
190
90
84
82
196
178'
170
94
176
178
184
192
172
86
174
60'
194
60
100
96
62'
98
62

FIG. 8

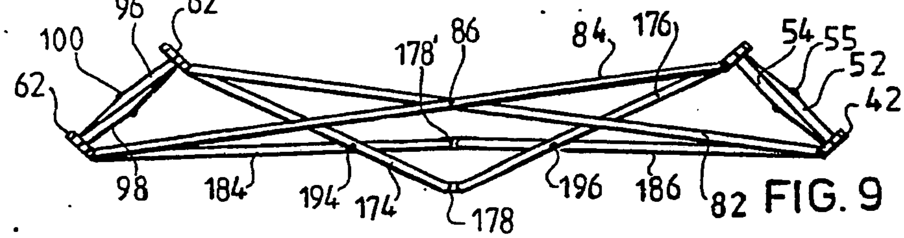
96
62'
100
62
178'
86
84
176
54
55
52
42
98
184
194
174
178
196
186
82

FIG. 9

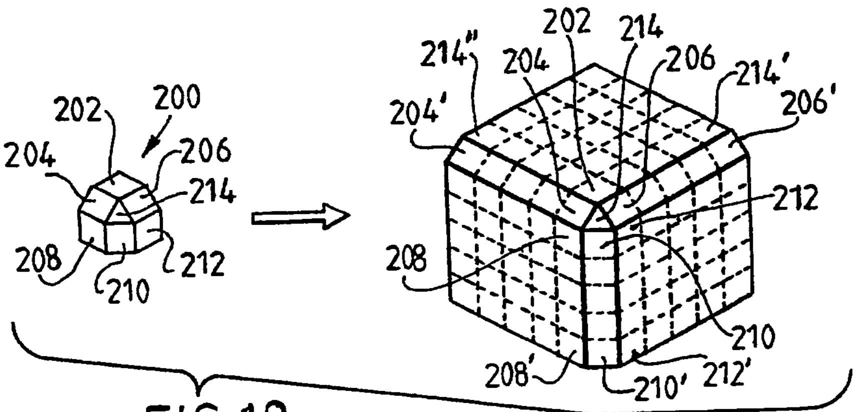
200
202
204
206
214
208
210
212
214"
204'
214'
206'
208'
210'
212'

FIG.10

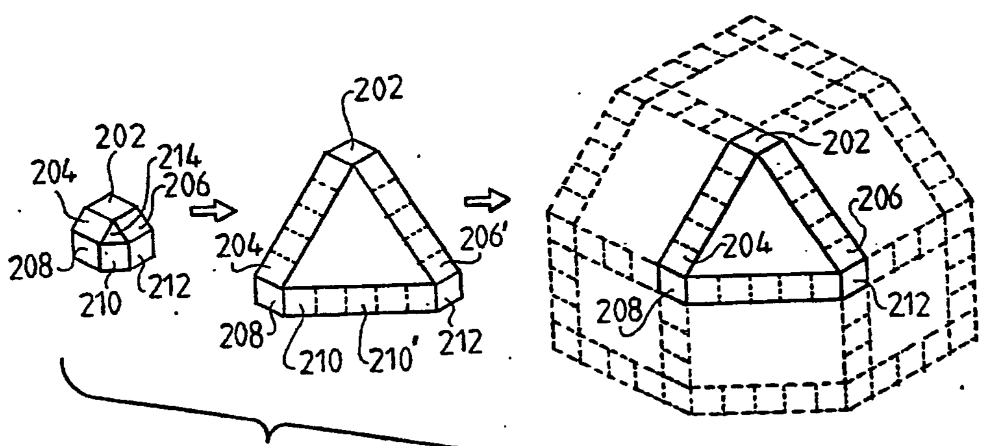
202
204
214
206
208
210
212
206'
210'

FIG.11